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Reconstructive

Distally-based Peroneus Brevis Turnover Muscle Flap in the Reconstruction of Soft Tissue Defects

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Background: Reconstruction of the distal 3rd of the lower leg requires either local or free flap coverage if tendons or bones are exposed. The distally based, pedicled peroneus brevis (PB) flap has been shown to be a valid option in the management of distal 3rd lower limb injuries. Herein, we present 21 cases treated with distally-based PB muscle flaps between May 2017 and September 2019. The defect location varied, and included defects over the lateral and medial malleolar areas, distal tibia (middle and distal 3rd junction, and the distal 3rd), and Achilles tendon area.
Methods: The PB was dissected from the lateral fibula and intermuscular septa in a cephalic to caudal direction, to a point no lower than 7 cm proximal to the lateral malleolus tip. This preserved most distal vascular perforators to the muscle, and afforded sufficient mobilization to allow successful turn-over of the muscle, with transposition into the defect within 30 minutes of tourniquet time. A meshed skin graft completed the intervention.
Results: The metalwork was removed in all chronic cases (10/21), as bone union had occurred. All flaps survived completely. One patient partially lost the skin graft; the wound was healed by secondary intention. No major complications occurred and no significant patient discomfort was noted. All wounds healed completely by 9 weeks of follow-up.
Conclusion: The PB turnover muscle flap is a versatile flap, ideally suited to manage up to moderately sized defects of the distal 3rd of the lower leg, with negligible postoperative morbidity. *(Plast Reconstr Surg Glob Open 2020;8:e3290; doi: 10.1097/GOX.0000000000003290; Published online 18 December 2020.)*

INTRODUCTION

Soft-tissue defects in the distal 3rd of the lower leg are one of the most challenging reconstructive defects that plastic surgeons face. Numerous local, regional, and free flaps have been proposed to address wounds in this challenging anatomical area.[1–10] Reconstruction of defects in the distal 3rd of the lower leg is associated with a higher complication rate, due to the paucity of reliable local flaps and the inherently limited amount of locally available tissue. A further reason for the poor success rate of local flaps in this area is the small radius of flap extension in the distal direction.[3,11–14] This has resulted in free tissue transfers often being recommended as the default treatment modality of choice.

Free tissue transfers and the unavoidable need for microvascular expertise are costly, complex, and time-consuming interventions[5,15,16]; additionally, not all patients are willing, or even healthy enough, to undergo such complex interventions. Thus, there is a constant quest to identify reliable local alternatives for reconstruction of distal 3rd lower limb soft-tissue defects. One such example is the peroneus brevis (PB) turnover flap,[17,18] which has been confirmed as a type-IV flap that can be transposed distally in a reliable fashion, without disturbing the distal perforators.[19]

The peroneus longus muscle is located superficial to the PB in the lateral compartment; the extensor digitorum longus is located anteriorly, in the anterior compartment,

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Fig. 1. Photograph depicting a lateral incision to the right lower leg, through the skin and subcutaneous tissue, with the deep fascia opened along the length of the lower leg. The peroneus longus is retracted anteriorly, to reveal the deeper PB. Note that the peroneus longus originates from the upper two-thirds, and the PB from the lower two-thirds, of the fibula and interosseous membranes.

and the flexor hallucis longus is located posteriorly, in the posterior compartment (Fig. 1). The PB originates from the middle and lower thirds of the lateral aspect of the fibular shaft, as well as the anterior and posterior intermuscular septa, taking its course posterior to the lateral malleolus, where it also becomes tendinous, inserting into the tuberosity of the base of the 5th metatarsal bone. Its motor supply comes from the superficial peroneal nerve, superficially located in the lateral compartment,[17] immediately deep to the deep fascia of the lower leg. The vascular supply originates from the posterior tibial artery.

An almost constant pattern of vascular supply allows for swift flap elevation, with negligible postoperative donor site morbidity,[18–20] resulting in the transfer of adequate amounts of tissues to cover moderate defects of the medial and lateral ankle region, including the junction of the middle and distal 3rd of the tibia, the distal 3rd of the tibia, and the Achilles tendon area. Herein, we report our experience with 21 patients who underwent successful reconstruction of soft-tissue defects of the distal lower leg with a split skin graft-covered PB muscle turnover perforator flap.

PATIENTS AND METHODS

From May 2017 to September 2019, the first author performed 21 reconstructions with distally based pedicled PB muscle turnover flaps in 21 patients (9 women, 12 men; age range, 28–88 years). Ten cases were classified as chronic (defect being more than 3 months old), and 11 cases as acute. The 10 chronic cases required removal of metalwork from the lateral malleolar area due to infection or unstable scars, which led to repeated wound breakdown.

Inclusion criteria for consideration of a PB flap were as follows: wounds to the lower half of the lower leg; chronically infected metalwork in the distal lower leg; chronic unstable scars of the distal lower leg; wound breakdown after infected Achilles tendon repair; low-to-moderate energy injury for acute cases; and wound size not exceeding a 3rd of the lower leg length. The length of the soft-tissue defects varied from 5 to 14 cm, and the width from 4 to 5 cm. The cases according to anatomy were as follows:

a) The lateral malleolus (10 cases): These were chronically infected cases with unstable overlying scars after bone union, requiring soft-tissue debridement over the distal fibula and removal of metalwork.
b) Tibial fractures of the distal 3rd (3 cases). These were acute fractures of the tibia and fibula affecting the distal 3rd, requiring open reduction internal fixation. Within 3 weeks of open reduction internal fixation, they were complicated with wound breakdown, requiring soft tissue coverage.
c) Junction of the middle 3rd with the distal 3rd of the tibia (2 cases). The first case was a fracture that was treated with plating; 6 months later, the metal work became infected due to an acute hematogenous infection and required removal (Fig. 2). The second case was an acute fracture treated with intramedullary nailing following repatriation, after initial treatment with an external fixator abroad (Figs. 3–9).
d) The medial malleolus (2 cases). Both cases suffered total soft tissue loss, including the periosteum, exposing bone (not related to metalwork).
e) Achilles tendon area breakdown after repair (3 cases; not related to metalwork).
f) Distal 3rd of the anterior aspect of the right lower leg (1 case). This patient sustained skin degloving, with total division of the extensor hallucis longus, extensor digitorum longus, and tibialis anterior tendons, due to a mechanical fall, requiring tendon repair and PB muscle flap with skin graft coverage (not related to metalwork).

Operative Technique

Under general anesthesia, the patients were positioned in the supine position on the operating table, with a sandbag under the ipsilateral hip, to allow easier internal rotation of the hip and, thus, easy access to the whole length of the lateral aspect of the lower limb. The fibular head and tip of the lateral malleolus were marked, as was a point 7 cm proximal to the tip

Fig. 2. Case 1: The defect was due to an old open reduction internal fixation with infected metalwork; the metalwork was removed and the bone was debrided (medial tibia).

Fig. 3. The lateral lower limb incision, with the isolation of PB.

Fig. 4. The PB was tunneled under anterior skin bridge of distal lower limb to reach the soft tissue defect.

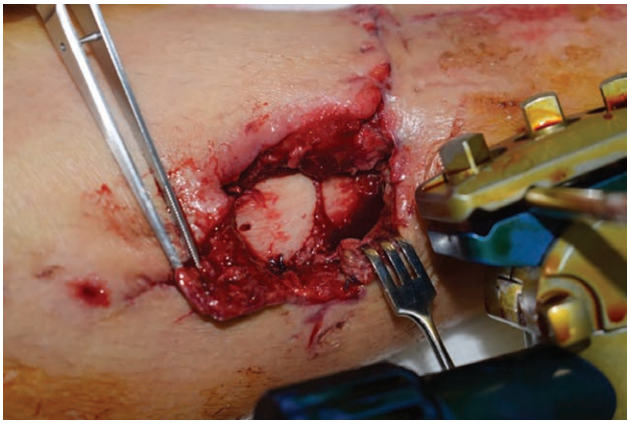

Fig. 5. The PB is shown in situ, with skin coverage of the wound.

of the lateral malleolus. This point indicated the maximal point of mobilization of the muscle (pivot point), approximately coinciding with the most distal arterial perforators to the muscle. After leg elevation for 1 minute, a tourniquet was inflated at 300 mm Hg to afford a bloodless field.

Fig. 6. Case 2: The defect was due to a fracture of the middle and distal 3rd tibia, initially treated with external fixator abroad. The case was treated with debridement and intramedullary nailing after repatriation.

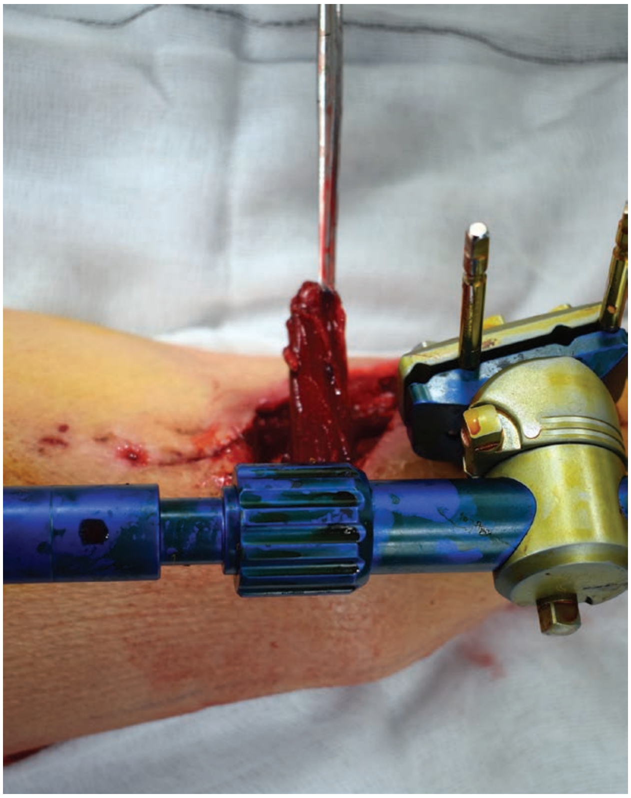

Fig. 7. The PB was isolated.

A skin incision was placed along the lateral aspect of the lower leg, on a line drawn to connect the fibular head and lateral malleolar tip. The incision commenced at the junction of the proximal and middle 3rd of the lower leg and was extended to the soft-tissue defect.

After the subcutaneous tissues and deep fascia were incised with diathermy, the peroneus longus muscle was reflected posterolaterally with blunt dissection, exposing the superficial peroneal nerve, superficial to the PB muscle. Working from the most proximal point of the origin of the PB muscle, in a craniocaudal direction, the PB muscle was gently scraped off the bone and interosseous membranes.

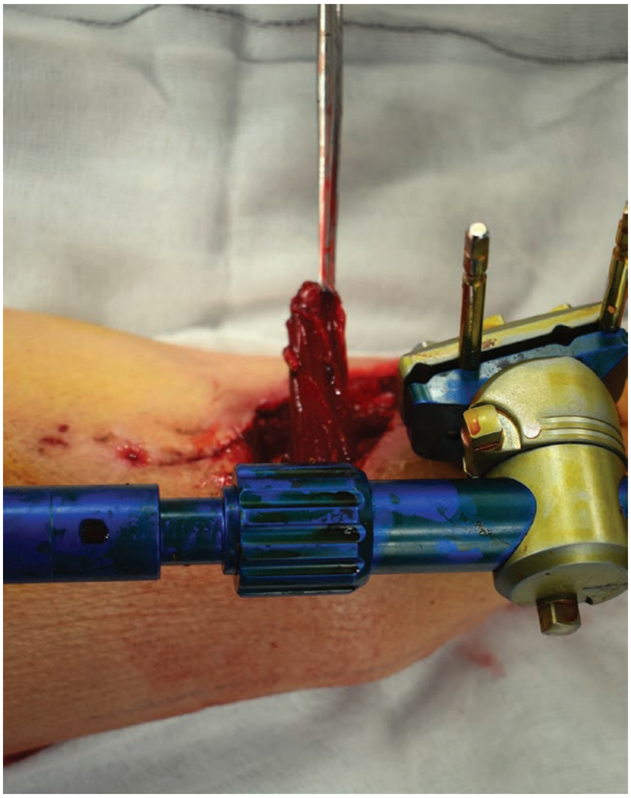

Fig. 8. The PB was tunneled under an anterior skin bridge to reach the defect.

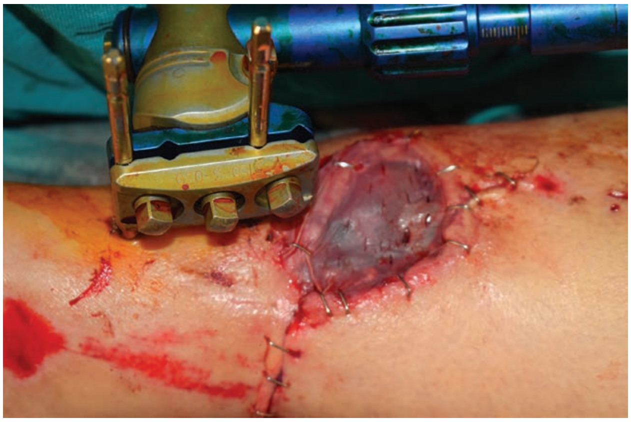

Fig. 9. The PB is shown covering entire soft tissue defect.

Fig. 10. Nine weeks postoperative photograph showing the healing of the wound.

Table 1. Summary of the Surgical Steps:

Ten Surgical Steps:
1. Incise skin with knife
2. Incise subcutaneous tissue with coagulation diathermy
3. Incise deep fascia with cutting diathermy
4. Important: identify the superficial peroneal nerve (immediately deep to the deep fascia)
5. Important: perform posterolateral reflection of the peroneus longus muscle off the PB muscle (dissection with bipolar diathermy: start at the caudal, tendentious end of the peroneus longus muscle, in a caudal-to-cephalic direction)
6. Identify the most cephalic part of the PB muscle (the point at which the superficial peroneal nerve dips deep)
7. Mobilize the PB muscle by scraping off the fibula and interosseous membranes with a knife
8. Release tourniquet for hemostasis
9. Set the flap with Vicryl Rapide 4/0, followed by skin grafting, secured with clips
10. Perform closure of the deep fascia (5 sutures with PDS 3/0) and skin closure with clips

The first author's technique of choice was to use a scraping motion with a 15 blade, rather than actually cutting the muscle, to prevent accidentally damaging the muscle.

During muscle elevation, the distance to the defect was repeatedly assessed and checked against the length of muscle elevated to prevent excessive mobilization of the PB muscle. As soon as sufficient length had been elevated to cover the respective defect completely, dissection was ceased. The cephalic portion of the muscle was reflected in a caudal direction to cover the entire defect, which was either reached by excising the intervening skin (if the defect was over the lateral malleolus or Achilles tendon area) or tunneled in a subcutaneous fashion to reach the defect area (if the defect was located over the distal tibia or medial malleolus).

The tourniquet was deflated after elevation of the PB muscle and before closure of donor site and setting of the flap. Hemostasis was ensured before the wounds were closed. The donor incision was closed with 5–8 PDS 3/0 sutures, reapproximating the deep fascia of the lower leg, followed by skin staples. The PB muscle was fixed in the target location with Vicryl Rapide 4/0 sutures, before a 1:1.5 meshed split skin graft (8/1000 thickness) was secured with skin staples. The skin graft was taken from the ipsilateral medial calf. All clips were removed by the 21st postoperative day. The 10 surgical steps are summarized in Table 1.

Postoperative Procedures

All patients remained in bed with strict leg elevation for 5 days postoperatively, under intravenous antibiotics (Co-Amoxiclav, 1.2 g intravenously, 3 times daily). Pre-emptive injections for anticoagulation (Tinzaparin subcutaneously, once daily) were continued for 29 days postoperatively.

Table 2. Patient Characteristics

Patient	Age, Sex, ASA	Comorbidities	Defect Etiology	Defect Location and Exposed Structure	Defect Dimension and Type	Tourniquet Time and Total Operation Time	Complications and Management
1	88, M, III	HTN, BPH, dementia	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	10 × 5 cm, chronic	29 min and 42 min	Nil
2	49, F, II	DM, learning difficulty	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	12 × 6 cm, chronic	28 min and 44 min	Nil
3	56, M, III	Smoker, depression, non-compliant, COPD, DM, HTN	Mechanical fall, ORIF, wound breakdown, metalwork removal 6 months prior, wound breakdown	#Lateral malleolus, ORIF	15 × 8 cm, chronic	29 min and 45 min	Partial graft loss (50%), conservative management
4	78, M, I	Nil	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	9 × 4 cm, chronic	21 min and 35 min	Nil
5	81, F, II	HTN, cCOPD	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	3 × 6 cm, chronic	23 min and 39 min	Nil
6	65, F, II	DM, HTN	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	5 × 6 cm, chronic	22 min and 40 min	Nil
7	72, F, II	DM, COPD	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	12 × 4 cm, chronic	N/A	Nil
8	28, M, I	Schizophrenia	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	8 × 4 cm, chronic	22 min and 35 min	Nil
9	78, F, II	HTN	Mechanical fall, ORIF, wound breakdown, metalwork removed	#Lateral malleolus, ORIF	7 × 4 cm, chronic	23 min and 39 min	Nil
10	52, M, II	Obese, smoker	Wound breakdown after Achilles tendon repair	Achilles tendon area	10 × 3 cm, acute	24 min and 39 min	Nil
11	45, M, II	DM, smoker	Wound breakdown after Achilles tendon repair	Achilles tendon area	9 × 3 cm, acute	22 min and 40 min	Nil
12 (Fig. 2)	36, M, I	Nil	Distal tibial fracture after RTA, Old ORIF with hematogenous infection after fracture healed	Junction of the middle and distal 1/3 of tibia	7 × 4 cm, acute	22 min and 38 min	Nil
13 (Fig. 3)	46, F, I	Nil	Distal tibial fracture after bicycle accident, ex-fix followed by IM nailing	Junction middle and distal 1/3 of tibia	8 × 4 cm, acute	21 min and 42 min	Nil
14	43, M, I	Smoker	Bicycle fall, soft tissue loss of the medial malleolus, including the periosteum	Medial malleolus	5 × 7 cm, acute	23 min and 49 min	Nil
15	39, M, I	Nil	Scaffolding fall, soft tissue loss of the medial malleolus, including the periosteum	Medial malleolus	6 × 6 cm, acute	22 min and 47 min	Nil
16	52, F, II	HTN, smoker, non-compliant	Mechanical fall, EHL, EDL, TA transection, skin degloving	#Tibia, fibula, distal 1/3	14 × 6 cm, acute	29 min and 39 min	Nil
17	65, F, II	DM, HTN	Mechanical fall, ORIF, unstable scar, metalwork removed	#Lateral malleolus, ORIF	5 × 6 cm, chronic	22 min and 40 min	Nil
18	53, M, II	DM, smoker	Wound breakdown after Achilles tendon repair	Achilles tendon area	6 × 3 cm, acute	N/A	Nil
19	32, M, I	Smoker	Ladder fall, ORIF, wound breakdown, metalwork salvaged	#Tibia, fibula, distal 1/3	9 × 3 cm, acute	20 min and 39 min	Nil
20	79, F, II	Atrial fibrillation, hypercholesterolaemia	Mechanical fall, ORIF, wound breakdown, metalwork salvaged	#Tibia, fibula, distal 1/3	8 × 2 cm, acute	25 min and 40 min	Nil
21	60, M, II	HTN, smoker	Wound breakdown after Achilles tendon repair	Achilles tendon area	7 × 3 cm, acute	25 min and 45 min	Nil

BPH, benign prostatic hypertrophy; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; EDL; extensor digitorum longus; EHL, extensor hallucis longus; HTN, hypertension; IM, intramedullary; ORIF, open reduction internal fixation; RTA, road traffic accident; TA, tibialis anterior.

All patients were mobilized starting on day 5 postoperatively. Cases with fractures were mobilized under non-weight bearing for 6 weeks, followed by partial weight bearing. Cases without bone injuries were allowed to fully weight bear after day 5 postoperatively. Follow-up for all patients at the clinic was continued till 3 months (Fig. 10), and follow-up continued another 9 months by phone.

RESULTS

During the study period, 21 cases (12 men and 9 women), comprising 11 acute and 10 chronic cases, underwent reconstructions with distally based pedicled PB muscle turnover flaps. The tourniquet time ranged from 21 to 29 minutes at 300 mm Hg. The details of each case are provided in Table 2.

All patients had an uneventful recovery, with the exception of one male patient with a chronic defect who was non-compliant. He refused to elevate his leg, left the ward repeatedly to smoke (starting day 1 postoperatively), and picked at his wounds. This patient sustained a superficial *Staphylococcus aureus* infection, which led to a skin graft loss of 50%. This required an additional course of intravenous Flucloxacillin (1 g, 4 times per day, for 7 days); the wound was managed conservatively and the patient remained in the hospital for a total of 6 weeks, due to social reasons. All patients experienced extensive flap edema; the expected postoperative edema settled within 6 weeks in all cases, and the flap adjusted its contour to the leg in a satisfactory manner in all 21 cases.

The follow-up period was six months for soft-tissue injury cases that were not related to bone fractures and did not have metalwork in situ. These were 6 such cases, in total: 2 cases with total soft tissue loss around the medial malleolus, 3 cases with Achilles tendon area breakdown after infected repair, and 1 case of soft tissue degloving of the skin associated with a total division of the extensor hallucis longus, extensor digitorum longus, and tibialis anterior tendons over the distal 3rd of the anterior aspect of the right lower leg.

The remaining 15 cases presented with either acute fractures or infected metalwork, and were followed up for 12 months after the initial presentation, to ensure stable wound coverage without osteomyelitis. To date, none of these cases have returned to our unit.

DISCUSSION

Defects of the distal 3rd of the lower limb are common and pose a particularly challenging problem for plastic surgeons. Numerous flaps have been described to address this issue. Adipofascial flaps have the benefits of being simple to raise and versatile, when employed in cases of small-to-moderate defects.[21] One such example is the distally based sural artery flap, first described by Masquelet et al in 1992.[22] The sural artery flap is an excellent choice for the reconstruction of even larger soft-tissue defects of the lower limb if the flap is delayed, as this has been shown to improve perfusion of the flap, resulting in an increased viability.[2] However, patients who are elderly or suffer from peripheral vascular disease are not good candidates for this type of flap, due to its high complication rate[23] in this patient category. In addition, adipofascial flaps do not offer much protection against bacterial infection, when compared with more vascular and robust muscle flaps.

Muscular flaps are the first choice when dealing with osteomyelitis[1,6,10,16] and soft tissue infection, as there is increased blood flow in denervated muscle flaps, due to a reduction in vascular resistance.[24,25] Free flaps are the first choice when dealing with defects of the distal 3rd of the lower leg, because of their good vascular supply and adequate tissue volume.[15] Their disadvantages, however, include donor-site morbidity, increased operation time, use of major vessels of the leg, costly microsurgical equipment, and the need for microvascular expertise; furthermore, not all patients are willing or healthy enough to endure the lengthy free tissue transfer procedures. The PB turnover flap was first described by Mathes and Nahai[17] in 1997. In 2001, Eren et al[18] published an article demonstrating the use of the PB flap in 19 patients, as a valid alternative to free tissue transfers. Initially the PB flap was described as a type-II muscle flap, and was used as such for coverage of defects in the distal 3rd of the leg,[26,27] until it was reclassified as a type-IV flap (due to its numerous vascular pedicles) by Taylor and Pan in 1998.[14]

A cadaver dissection, which was published by Yang et al in 2005,[19] confirmed that the distal pedicle, which originated from the posterior tibial artery, was located, on average, 3–6 cm proximal to the tip of the lateral malleolus, thus proving that the flap could be transposed distally in a reliable fashion, without disturbing these distal perforators. The reverse PB flap offers many benefits in comparison with other reconstructive options. This includes a swift and safe surgery, resulting in stable soft tissue coverage of exposed ligaments, tendons, and the bone, without the need to sacrifice one of the major arteries of the leg, and with negligible postoperative donor site morbidity, as preservation of the peroneus longus muscle preserves foot eversion.[17–20]

CONCLUSIONS

The first author successfully performed reconstruction with a PB muscle turnover flap to cover defects of the medial and lateral malleoli, dorsum of the ankle, distal 3rd of the tibia (including the junction of the middle 3rd and distal 3rd of the tibia), and Achilles tendon area. As long as the peroneus longus is preserved, compromise in ankle stability is not expected. In summary, the reverse PB muscle flap is a versatile flap, and is optimally located to deal with small and moderate defects in the distal 3rd of the lower leg. This technique is relatively simple and does not require advanced microsurgical techniques.

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REFERENCES

1. Arnold PG, Yugueros P, Hanssen AD. Muscle flaps in osteomyelitis of the lower extremity: a 20-year account. *Plast Reconstr Surg.* 1999;104:107–110.
2. Kneser U, Bach AD, Polykandriotis E, et al. Delayed reverse sural flap for staged reconstruction of the foot and lower leg. *Plast Reconstr Surg.* 2005;116:1910–1917.
3. Hallock GG. Utility of both muscle and fascia flaps in severe lower extremity trauma. *J Trauma.* 2000;48:913–917.
4. Jackson IT, Scheker L. Muscle and myocutaneous flaps on the lower limb. *Injury.* 1982;13:324–330.
5. Wells MD, Bowen CV, Manktelow RT, et al. Lower extremity free flaps: a review. *Can J Surg.* 1996;39:233–239.
6. Attinger C, Cooper P. Soft tissue reconstruction for calcaneal fractures or osteomyelitis. *Orthop Clin North Am.* 2001;32:135–170.
7. Ayyappan T, Chadha A. Super sural neurofasciocutaneous flaps in acute traumatic heel reconstructions. *Plast Reconstr Surg.* 2002;109:2307–2313.
8. Hsieh CH, Liang CC, Kueh NS, et al. Distally based sural island flap for the reconstruction of a large soft tissue defect in an open tibial fracture with occluded anterior and posterior tibial arteries—a case report. *Br J Plast Surg.* 2005;58:112–115.
9. Greant P. The distally based superficial sural flap for reconstruction of the lower leg and foot. *Br J Plast Surg.* 1997;50:295–296.
10. Smith IM, Austin OM, Batchelor AG. The treatment of chronic osteomyelitis: a 10 year audit. *J Plast Reconstr Aesthet Surg.* 2006;59:11–15.
11. Hallock GG. Clinical scrutiny of the de facto superiority of proximally versus distally based fasciocutaneous flaps. *Plast Reconstr Surg.* 1997;100:1428–1433.
12. Benito-Ruiz J, Yoon T, Guisantes-Pintos E, et al. Reconstruction of soft-tissue defects of the heel with local fasciocutaneous flaps. *Ann Plast Surg.* 2004;52:380–384.
13. Touam C, Rostoucher P, Bhatia A, et al. Comparative study of two series of distally based fasciocutaneous flaps for coverage of the lower one-fourth of the leg, the ankle, and the foot. *Plast Reconstr Surg.* 2001;107:383–392.
14. Taylor GI, Pan WR. Angiosomes of the leg: anatomic study and clinical implications. *Plast Reconstr Surg.* 1998;102:599–616; discussion 617.
15. Gonzalez MH, Tarandy DI, Troy D, et al. Free tissue coverage of chronic traumatic wounds of the lower leg. *Plast Reconstr Surg.* 2002;109:592–600.
16. Kuokkanen HO, Tukiainen EJ, Asko-Seljavaara S. Radical excision and reconstruction of chronic tibial osteomyelitis with microvascular muscle flaps. *Orthopedics.* 2002;25:137–140.
17. Mathes SJ, Nahai F. Peroneus brevis flap. In: Mathes SJ, Nahai F, eds. *Reconstructive Surgery: Principles, Anatomy And Technique.* New York: Churchill-Livingstone; 1997:1437–1446.
18. Eren S, Ghofrani A, Reifenrath M. The distally pedicled peroneus brevis muscle flap: a new flap for the lower leg. *Plast Reconstr Surg.* 2001;107:1443–1448.
19. Yang YL, Lin TM, Lee SS, et al. The distally pedicled peroneus brevis muscle flap anatomic studies and clinical applications. *J Foot Ankle Surg.* 2005;44:259–264.
20. Koski EA, Kuokkanen HO, Tukiainen EJ. Distally-based peroneus brevis muscle flap: a successful way of reconstructing lateral soft tissue defects of the ankle. *Scand J Plast Reconstr Surg Hand Surg.* 2005;39:299–301.
21. Lai CS, Lin SD, Chou CK. Clinical application of the adipofascial turnover flap in the leg and ankle. *Ann Plast Surg.* 1992;29:70–75.
22. Hallock GG. Complications of 100 consecutive local fasciocutaneous flaps. *Plast Reconstr Surg.* 1991;88:264–268.
23. Masquelet AC, Romana MC, Wolf G. Skin island flaps supplied by the vascular axis of the sensitive superficial nerves: anatomic study and clinical experience in the leg. *Plast Reconstr Surg.* 1994;93:1026–1027.
24. Lorenzetti F, Suominen S, Tukiainen E, et al. Evaluation of blood flow in free microvascular flaps. *J Reconstr Microsurg.* 2001;17:163–167.
25. Lorenzetti F, Tukiainen E, Asko-Seljavaara S. Intraoperative haemodynamic evaluation of the free latissimus dorsi flap. Paper presented at: 4th European Conference of Scientist and Plastic Surgeon Meeting, Oct 27–28, 2000; Paris, France.
26. Mathes SJ, Nahai F. Classification of the vascular anatomy of muscles: experimental and clinical correlation. *Plast Reconstr Surg.* 1981;67:177–187.
27. Ensat F, Hladik M, Larcher L, et al. The distally based peroneus brevis muscle flap-clinical series and review of the literature. *Microsurgery.* 2014;34:203–208.